R E P O R T R E S U M E S

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AN INVESTIGATION OF THE RELATIONSHIPS BETWEEN ARTICULATORY DEVELOPMENT OF PHONETIC DISCRIMINATION AND WORD SYNTHESIS ABILITIES IN YOUNG MENTALLY RETARDED CHILDREN AND NORMAL CHILDREN.

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THE INVESTIGATION STUDIED THE RELATIONSHIPS BETWEEN (1) AUDITORY PERCEPTUAL ABILITIES AND ARTICULATION DEVELOPMENT AND (2) INVESTIGATED QUALITATIVE AND QUANTITATIVE ASPECTS OF THESE ABILITIES AS SHOWN IN MENTALLY RETARDED AND NORMAL CHILDREN. THE STUDY INVOLVED MONTHLY TESTING OF ARTICULATION, PHONETIC DISCRIMINATION, AND PHONETIC SYNTHESIS ABILITY OF TWO GROUPS OF CHILDREN OVER A PERIOD OF 14 TO 18 MONTHS. EACH OF THE TWO SUBJECT GROUPS CONSISTED OF CHILDREN WITH MENTAL AGES BETWEEN 4 AND 7 YEARS. THE FIRST GROUP INVOLVED 46 MENTALLY RETARDED CHILDREN, (IQ 50-75) WHILE THE SECOND GROUP INCLUDED 36 CHILDREN OF NORMAL INTELLIGENCE (IQ 90-110). THERE WERE NO DIFFERENCES FOUND BETWEEN AN INSTITUTIONALIZED AND A PUBLIC SCHOOL POPULATION OF MENTALLY RETARDED CHILDREN IN ARTICULATION, PHONETIC DISCRIMINATION, AND WORD SYNTHESIS ABILITIES. IN ADDITION, ARTICULATORY ABILITY OF THE MENTALLY RETARDED DID NOT DIFFER FROM THAT OF A NORMAL POPULATION OF EQUIVALENT MENTAL AGE WITH RESPECT TO THE NUMBER OF ARTICULATION ERRORS PRESENT DURING THE DEVELOPMENT YEARS OF CHILDHOOD. FROM THESE RESULTS, IT WOULD APPEAR THAT USE OF SUCH AUDITORY PERCEPTUAL ACTIVITIES AS THOSE USED IN THIS STUDY FOR IMPROVEMENT OF ARTICULATORY DEVELOPMENT AMONG NONSPEECH DEFECTIVE CHILDREN IS OF LITTLE VALUE. THE USE OF SUCH ACTIVITIES WITH ARTICULATION DEFECTIVE SUBJECTS HAS ALSO YIELDED EQUIVOCAL RESULTS. AS A RESULT OF THIS AND OTHER INFORMATION IT APPEARS THAT THERE IS MUCH TO BE LEARNED CONCERNING THE SKILLS REQUIRED FOR NORMAL ARTICULATION DEVELOPMENT. (GC)

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Introduction

The development of articulatory ability in children has been of increasing interest to speech and hearing therapists and to those concerned with developmental aspects of child behavior. At least three recent and major publications have been concerned almost wholly with articulation skills. Two of these were directed primarily toward consideration of defective speech articulation (1,2) while the other encompassed development of speech skills in a large sample of children at several age levels (3); two of these publications appeared since the initiation of the present study. (1,3). It is significant to note that each publication deals with objective aspects of our knowledge of articulation as provided through major research efforts.

Research has provided only a partial understanding of articulatory skill and its development. Relationships between articulation and other factors have not been clearly delineated despite repeated efforts. It is likely that the variation in the importance of individual factors from person to person as well as the complexity of human behavior continues to yield conflicting or equivocal results. Impairments of motor skill, intellectual retardation, emotional disturbance, bilingual environment and several other factors may result in articulatory problems, but it is apparent that they do not always do so. Frequently, it is found that presence of a single impairment is insufficient to cause defective articulation. As a result, there is much divergence of opinion

concerning etiology of articulatory defects as well as divergence in therapeutic rationale and procedures.

It is clear however, that the area of audition and its relationship to speech articulation has been of major interest to those concerned with understanding the development of articulation skills. Much of the previous research has been concerned with auditory abilities in children with articulation defects. Little attention has been given to auditory skills of non-speech defective children during the articulation developmental period. (Templin's recent work is a notable exception). The research has also been done with only a limited knowledge and sampling of the perceptual skills which may be classified under the broad term of audition. Despite these limitations, there is considerable evidence of the existence of positive relationships between auditory perceptual skills and articulation ability among certain articulation defective children.

There have been several attempts to analyze the basic auditory perceptual factors requisite to speech perception and production (4,5). The excellent historical and theoretical review of research in auditory perception by Harris(6) points up the difficulties in such study as well as the fact that we are only partly able to identify auditory skills.

Unfortunately, there have been very few efforts to construct tests which might measure certain of these auditory abilities which are known and almost no attempt to derive any normative data concerning them. A systematic exploration of the several auditory abilities in speech perception and production could add greatly to the understanding of both normal and abnormal speech and articulation development.

An increased knowledge of the role of any skill which relates to articulatory development can be of help to speech and hearing therapists and to classroom teachers alike. The frequent coincidence of articulation difficulties with reading and spelling problems not only suggests certain common etiological elements, but also points to the importance of more adequate understanding of the underlying processes involved in all areas of the language arts.

This study was an attempt to evaluate the role of two auditory perceptual functions and the development of articulation skills. The study was also concerned with these skills and developmental processes in children with retarded and normal intellectual abilities.

CHAPTER I

REVIEW OF RESEARCH AND STATEMENT OF PROBLEM

Review of Research

Fairbanks (7) in his discussion of a mechanical model of the speech system has provided a systematic overview of the process of speech production and control. One of the principal components of the model, the auditory monitoring system, is considered to be of great importance in the articulation process by Van Riper (8), Ainsworth (9), Davis (10) and numerous other authors. The logical justification for such a position becomes apparent when we remember that speech can be considered, in a limited sense, as an acoustic phenomenon. Hence, the production of speech must be judged or monitored according to the degree of congruence with acoustic perceptual models.

Many functional articulatory defective persons are completely unaware of their speech deviations until these are pointed out by someone else. Very frequently, they express amazement and protest that they do not approximate the number and severity of errors which are so readily apparent to others. Similarly, most children have very little awareness of their own errors which are present during the speech development period. As autocritical abilities develop however, awareness and modification in the articulatory pattern follows rapidly until an essentially adult pattern is reached by about eight years of age.. (3).

It is sometimes possible to view the presence of a functional articulation defect as a manifestation of some type of auditory perceptual deficiency. Many studies have provided strong evidence for such deficiencies. It may also be possible to view the rather wide variation in developmental rates of articulation skills in non-speech defective children as manifestations of varying degrees of auditory perceptual development. Some evidence for this view has been provided very recently by Templin (3).

Before proceeding with discussion of the research findings in audition and its relationships with articulation, we should consider certain of the skills which may be classified under audition. At least two studies of auditory ability with specific reference to speech perception, have been made using the technique of factor analysis. Hanley (5) attempted to isolate the factors underlying speech perception for persons with normal auditory acuity. His procedure employed an a priori selection of postulated factors for which a number of tests were constructed. He summarized the major findings of his study by concluding that speech perception is primarily influenced by the threshold of detectability for auditory stimuli and by synthesis; the latter was reported to be a reflection of the ability of the end organ-cortical hearing mechanism to supply parts of auditory stimuli which were unheard. Karlin (4) attempted to isolate auditory factors in speech perception in relation to the psycho-physical correlates of sound, i.e., pitch, loudness, timbre, and time. His results yielded factors which were somewhat similar to those of Hanley in addition to certain other factors. A more

complete discussion and integration of their findings with reference to articulation problems has been provided by Mange (11).

It should be noted that neither of these factor analytic studies utilized tests of phoneme discrimination. Hence, we have little indication of the abilities required in a phonetic discrimination task. It should also be noted that these studies were concerned with total speech perception and auditory function rather than with phoneme perception. The former is probably more complex than the latter and may therefore involve more factors. For the purposes of the present study it is necessary to pay particular attention to those auditory abilities which underly phoneme perception and discrimination on the assumption that they are more closely related to development of articulation skills.

Liberman (12) has summarized some of the recent research on speech perception with special emphasis on the acoustic cues which make it possible to distinguish individual phonemes. It is apparent from his presentation that phonetic discrimination is both an important and a rather complex ability. Two factors which appear to be especially important are the ability to discriminate and associate certain frequency positions and to recognize the transitions which exist between phonemes. The synthesis tests to be described later increase the difficulty of phonetic perception by eliminating these transitions which are of such importance.

Hanley, Karlin and Liberman have all pointed to the complexity of the auditory processes in speech perception. Many of the abilities which they found have been investigated as etiological factors in functional articulatory defects. The results of these studies have been almost wholly negative with the exception of two abilities

which hold promise for further evaluation, phonetic discrimination and phonetic synthesis.

There have been a number of studies concerned with phonetic discrimination in articulation defective children. Travis and Rasmus (13) administered a phonetic discrimination test utilizing 366 pairs of consonant-vowel combinations to which subjects responded "same" or "different". In their study normal speaking subjects achieved significantly higher scores at every age level than did the functional speech defectives. Carrell (14) using a recorded short form of the Travis-Rasmus test reported a significant difference between the normal and functional articulatory defective children with the normal subjects obtaining higher scores.

Hawthorne (15) reported that many more errors were made by her functional articulatory group than by her normal speaking group although no statistical analysis was reported. Mange (16) studied small groups of children with /r/ and /s/ defects and compared them with matched normal speaking children. The findings yielded significant mean differences in phonetic discrimination ability between normal and speech defective subjects and between those with /r/ and those with /s/ defects. Thus, it is probable that phonetic discrimination is related not only to functional articulatory defects, but also to type and severity of defect. Kronvall and Diehl (17) tested thirty functional articulatory defective and matched normal speaking children with a short form of the Travis-Rasmus test. Their results demonstrated highly significant mean differences between the groups in favor of the normal speaking children. Results

recently reported by Schiefelbusch and Lindsey (18) again indicate significant differences in discrimination ability between normal and functional speech defective children.

At least three studies have yielded results which failed to support the hypothesis of phonetic discrimination disability in articulation defects. Hall (19) using the Travis-Rasmus test and a test of her own construction found no significant differences between the normal and functional articulatory defective groups. Mase (20) and Hansen (21) also reported non-significant differences in phonetic discrimination ability between groups.

Despite the contradictory findings of the three studies mentioned it seems quite probable that a real discrimination disability exists in many functional articulatory defective children. The relatively large number of carefully controlled studies which reported significant differences and the logical relationship which discrimination bears to articulation are considerations of importance. Many factors can be postulated to explain the negative findings cited. Presentation of tests by oral means, the presence of discrimination differences which did not reach significance levels, and the lack or presence of a phonic approach to the language arts in the schools are such factors.

There is very little evidence concerning sound discrimination ability among the intellectually retarded. Schlanger and Gottsleben (22) and others have pointed to the possibility of some type of auditory perceptual deficiency in retarded children with articulatory difficulties. Schlanger (23) obtained a measure of sound discrimi-

nation in retarded children which showed that only a small percentage of those tested met the norms for non-retarded children. There have been few, if any, other studies of this ability in retarded children reported in the literature.

Word synthesis ability as utilized in this study refers to the ability to recognize distorted versions of familiar words when presented by auditory means. The type of distortion under consideration is that which results from omission of acoustic transitions between phonemes. The author's previous study of this ability indicated a relationship between synthesis and both number of articulatory errors and error type in certain articulatory defective children (11). The only other research concerning this ability that the author has found is implied in the tentative norms which Van Riper has given for a simple test of synthesis ability (8, page 196). There has been no study of this ability in children with retarded mental development.

In addition to the information provided by direct measures, some indirect evidence of relationships between auditory abilities and articulation development has been provided by Roe and Milisen (24) and Sayler (25). Their studies showed a progression in error type with increasing school grade levels. The progression ran from omission of phonemes to phoneme substitution and finally to phoneme distortion. Spriestersbach and Curtis (26) have suggested that this sequence may represent a type of auditory progression from lack of phoneme awareness to improved phoneme recognition and to successively finer phonetic discriminations.

Most authors who have been concerned with speech and articulation in the mentally retarded have expressed the opinion that it is incorrect to consider mental retardation per se as a cause of speech defects. Schlanger and Gottsleben (22) have taken special care to point this out in their recent article. They have also suggested deficiency in auditory skills as a possible cause of articulatory defect among retarded children. Consequently, it may be that similar relationships between auditory skills and articulation development may exist for the mentally retarded.

It has been shown that articulatory defects of retarded children are highly similar to those found in children of normal intelligence at comparable mental age levels (27, 28, 23, 29). Thus, we can at least postulate similarity of etiological factors from similar articulatory patterns and development. If auditory perceptual skills are of significance in the development of articulation for intellectually normal children, it is also likely that they are of significance for the mentally retarded.

Summary

This chapter has attempted to present the possible relationships between types of auditory deficiency and articulation skills in mentally normal and retarded children. Theoretical relationships have been discussed and previous research in these areas has been reviewed. Most of the previous research points to the existence of phonetic discrimination deficiency among functional articulation cases. The only study which has dealt specifically with word syn-

thesis ability has yielded results indicating a relationship between it and both number of articulatory errors and error type. One study, published after the initiation of this project has measured phonetic discrimination ability during the childhood years when articulatory development is progressing. Word synthesis ability has not been studied in young children during the speech development period.

Statement of the Problem

Very little information is available concerning the development of phonetic discrimination and its relationship to articulatory development in children during the years when articulation improvement normally occurs. There is no information regarding word synthesis and its relationships with articulatory development during this period of childhood speech improvement. Evidence is available indicating that articulation profiles of the mentally retarded are similar to those of normal children with comparable age levels. Functional articulation defects however, are not simply a function of mental age since there are many such children with intelligence within and above the normal range. This study has attempted to investigate the relationships between two auditory perceptual abilities and articulation development and to investigate qualitative and quantitative aspects of these abilities as shown in mentally retarded and normal children. The principal experimental questions with which this study was concerned were:

1. Do mentally retarded and mentally normal children improve in phonetic discrimination ability during the articulation development period?

2. Do mentally retarded and mentally normal children improve in word synthesis ability during the articulation development period?
3. What relationship exists between phonetic discrimination and articulation development in mentally retarded and mentally normal children?
4. What relationships exist between word synthesis ability and articulation development in mentally retarded and mentally normal children?
5. What relationships exist between phonetic discrimination and word synthesis abilities in mentally retarded and in normal children?

CHAPTER II

PROCEDURES

A. General Statement of Plan

Phonetic discrimination and phonetic synthesis abilities were assessed 12 times during a 15-month period by means of tape recorded tests. Articulation ability was analyzed at the times of auditory testing. Children with normal intellectual abilities and those with retarded intellectual abilities were utilized as subjects. None of the subjects selected had completed their articulatory development.

B. Subject Selection and Description

A group of 60 children of normal intelligence was selected from the Syracuse Public Schools. As testing progressed over the months, the population declined due to transfer to other school systems, chronic illness and miscellaneous factors. The normal children who were available throughout the entire testing period numbered 36 with 18 boys and 18 girls.

The 1937 Revision of the Stanford-Binet, Form L, was used to assess intelligence. A few of the subjects selected had been tested with this form of the Binet within one school year preceding subject selection; in these cases the scores obtained by the school psychologists were used. The great majority of subjects were individually tested by the project staff. All intelligence and mental age scores were computed as of April 1, 1957. Scores were extrapolated approximately five months to September 1, 1957 when regular monthly testing procedures were begun. Table I contains the intelligence and chronological and mental age analyses for the two subject groups.

Table I

Means, Medians & Ranges of Mental Ages, Chronological Ages and Intelligence Quotients for Normal and Retarded Subjects

	M. A.		C. A.		I. Q.	
	Mean	Median	Mean	Median	Mean	Median
Normals	6-5	6-3	6-8	6-5	96	97
	Range		Range		Range	
	5-4 to 8-3		5-10 9-1		86 to 110	
Retarded	6-1	6-2	9-10	9-11	62	62
	Range		Range		Range	
	4-4 7-9		6-2 to 13-6		50 - 75	

The retarded group was selected from special classes of the Syracuse Public Schools and from the Rome State School at Rome, New York. The initial group numbered 60 with 40 from Syracuse and 20 from Rome. The total number of retarded children who were available throughout the entire testing period was 46; 26 from Syracuse schools and 20 from Rome State School.

Descriptive data for the retarded group are also contained in Table I. Procedures for assessment of intelligence for these subjects were identical to those described for the normal group. The public school retarded included 14 boys and 12 girls while the Rome State School retarded included 11 boys and 9 girls.

Each subject was given an audiometric sweep test at 15 db at all octave frequencies from 250 through 8000 cycles. It was required that these frequencies be passed in each ear. This very strict

hearing requirement appeared to be necessary because of the importance of assessing auditory perceptual abilities apart from function of the end-organ. An oral peripheral examination was given to exclude any who exhibited formation or function of the speech structures which might make normal articulation development difficult or impossible. Subjects were also required to be able to retain and reproduce three series of three phonemes each to insure their ability to retain such stimuli sufficiently well to respond to the phonetic synthesis test. Finally, it was necessary to check very carefully for signs or history of organic pathology. All of the subjects selected met the criteria for familial retardation described by Riggs and Rain. (30)

Medical consultation was available to assist in subject selection. During the course of testing and despite the complete lack of any previous suggestive information pointing toward organic pathology, there were three children whose behavior pointed toward the possibility of brain damage. As a result, these children were excluded from further testing.

Templin's Articulation Screening Test (31) was administered to all subjects to assess articulatory ability. This test required the subjects to produce 40 words containing 21 different consonantal phonemes for which articulation was judged. The phonemes were contained in 27 blends and 24 singletons. It was required that each subject repeat the 40 words after the examiners. As the words were produced, articulatory errors were noted. Those children included in the study made a total of five or more articulatory errors on the

initial administration of the articulation test. The test words are contained on the scoring sheets in Appendix A.

Templin reports test-retest reliabilities between .93 and .99 on single age groups of young children.(31,p.323) Articulation judgements were made by a total of four different examiners; many of these judgements were made on different groups of children. Consequently, it was necessary to obtain estimates of their agreement when judging identical articulation performances. These estimates were made by tape recording the articulation testing of four children at the beginning of the monthly testing periods and those of four other children during the ninth testing period. These tapes were then judged by the examiners to determine the percentages of agreement for the various error types. One examiner judged only the initial four children since he was not on the staff throughout the entire study. Results of these comparisons are shown in Table II.

Table II

Percentage of Complete Agreement Among Four Examiners for Judgement of Articulatory Error Types

Distortions	Substitutions	Omissions	Normal Productions
77% (N=196)	85% (N=96)	94% (N=16)	96% (N=1428)

The agreement in Table II is with criterion judgements made by the project director. His judgements were completed after repeated listening to individual items contained on the tapes. Validity of these judgements was assumed to be very high because of extensive

training in this area of audition and because his judgements were found to be in high agreement with criterion measures in two other studies. (11,32)

The phonetic discrimination test was constructed in a similar fashion to those which have been used previously. There were 12 tests constructed each of which contained 24 paired word stimuli which were to be judged as "same" or "different". Familiar words were utilized as stimuli. These included fun, fine, thumb, sun, zipper, shoe, run, like, chair, and jump. These words contained the phonemes /f,θ,s,z, ʃ,r,l, tʃ/ and /dʒ/ as the initial sounds. The initial phoneme of the paired words was varied by omission, distortion, substitution, or normal production of that phoneme.

In order to restrict the length of the discrimination test, it was decided to break each major test into 2 portions. The first portion contained paired word stimuli for each of the 11 sounds with the normal-omission and substitution-substitution pairings. In addition, distortion-distortion pairings were included for 2 sounds (s) and (r). Thus, there was a total of 24 items in the initial portion of a discrimination test. The second portion contained the pairings normal-substitution and normal-normal for each of the 11 phonemes under test. Normal-distortion pairings were added for (s) and (r). Thus, this test also contained 24 paired items. These 2 portions of the discrimination tests formed the basic material for constructing other tests as required during the monthly assessments. The first portion and subsequent tests derived from it were numbered 1,3,5,7,9, and 11, while the second portion and those tests derived from it

were numbered 2,4,6,8,10, and 12. The items of each test were arranged in random order. Tests 3, 7, and 9 and tests 4, 8, and 12 reversed the order of presentation of the halves of the paired stimuli within items. Appendix B contains the discrimination test item pairs.

Following the planning for the content and order of presentation within each test, actual test construction was begun. This was done in a sound isolated room with a very low ambient noise level. The project director produced each of the paired word stimuli while keeping the intensity level nearly constant through monitoring with a General Radio Company Sound Level Meter, Type 759. As the items were spoken they were recorded on the Revere Tape Recorder, Model T700D, which was modified with an impedance matching transformer to utilize an Electro-voice 650 microphone.

The synthesis tests also were similar to that used previously (11). Each synthesis tests consisted of an auditory portion and a visual portion. The auditory stimuli utilized 75 different words which were selected as being likely to be familiar to very young children. They were selected from the 1000 most frequently used words as listed by Thorndike and Lorge (33). These words were of a monosyllabic nature and contained two or three phonemes. Fifteen tests* were

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*It was originally intended to utilize 15 monthly tests,, but preliminary evaluation made after 9 administrations suggested that little additional information would be obtained by completing the entire testing schedule. As a result, it was decided to conduct 12 administrations of all tests over a 14 month period. No testing was conducted during the months of July and August of 1958 since subjects were not easily accessible during this vacation period.

constructed in all and each test contained 15 different items; thus, a total of 225 items were contained in all of the tests, but only 75 different words were utilized since each word was used 3 times. Use of the words was so arranged that tests numbered 1, 6, and 11 contained identical words but in different random order. Similarly, tests 2, 7, and 12, sets 3, 8, and 13, sets 4,9, and 14, sets 5, 10, and 15, contained identical words in differing random order. The construction of each word or item of the synthesis tests was completed as follows: The project director produced and tape recorded a number of individual phonemes which were later put together in series to form a version of familiar words. This recording was done in a sound isolated room with low ambient noise level. Productions were monitored in intensity and tape recorded in an identical manner to that described for production of the discrimination tests. In cases where continuant and relatively steady vowels could be used, the sound was produced as a continuant. Thus, the vowel when required in a test was broken into many segments by taking portions of it to be used as necessary. For other non-continuant and dipthongal phonemes, individual productions of each were made.

Sections of the recorded phonemes were spliced together in the appropriate sequence corresponding to the words which were to make up the test items. For example, pieces of the tapes containing /ʃ, ɜ, t/ were spliced together in that order to form a version of the word "shirt". Distortion resulted from the fact that no transitions from phoneme to phoneme were included. Total duration of each word was one second; phonemes within the word were of one-half

or one-third second duration depending upon the number of phonemes required for the intended word. The total duration of one second was expected to result in maximum recognition of words (11)

A single word, constructed as described, comprised an item of the test. The task of the subjects was to identify the word which was being presented i. e., to synthesize the phonetic components into a meaningful auditory event. Appendix C contains the words utilized for each of the synthesis tests.

The visual portion of the synthesis test was added to make it easier for the children to recognize the word under test and to indicate their answers. For each item of the test, four different pictures were provided. Three of these pictures were inappropriate to the stimulus word while the fourth depicted the object or action appropriate to the word. Picture stimuli were of approximately equal size and were mounted by placing two pictures each on facing 8 X 11½ pages of a loose leaf binder. Placement of the appropriate and inappropriate pictures was randomized. Each set of 15 words, therefore, had 60 picture stimuli, 15 of each were appropriate and 45 inappropriate, thus giving each word 4 choices.

C. Test Administration

The articulation, discrimination, and synthesis tests were administered to each subject at monthly intervals from October, 1957 through June, 1958 and in September, October, and November of 1958. All Auditory testing was done through the use of a Revere T700D tape recorder which supplied S. G. Brown type K earphones. All tests were administered individually.

The articulation test was administered orally by each of the three examiners. The discrimination test was preceded by practice training to assure that each child could respond appropriately to the same-different concept. This was done by utilizing 2 pens, 2 pencils, 2 pennies, 2 nickels, and 2 keys. These were presented as identical and dissimilar pairs until children were thoroughly trained to discriminate same or different. Then the syllables [ma ,ti , lo ,bi , so , θo] were presented by identical and dissimilar pairs and the children were required to respond appropriately until they reached a criterion of 75% correct. Testing did not begin until it was apparent that the child understood the concept of same and different as applied to auditory stimuli. A similar training period was provided before administration of the synthesis test. The words utilized in this training included shoot, boot, chalk, sock, cake, and leaf. Training proceeded with these items until two-thirds correct responses were made.

The order of presentation of discrimination and synthesis tests by examiner is given in Table III. It should be noted that the test schedule for Examiner I was conducted by a staff member who completed graduate training after the first four months of testing. Another staff member was obtained to continue and complete the testing schedule for Examiner I.

It was desirable from the public relations point of view to have each examiner test a single group of children each month. From a statistical point of view, however, it was more appropriate to utilize rotation of the examiners in such a way that the children

would be tested equally by all examiners. A compromise procedure proved to be most useful. The examiners for the most part maintained a regular test schedule but in a number of instances it was possible to rotate the examiner where specially cooperative school personnel were present. Some rotation of an irregular nature also occurred as a result of the rather numerous transfers of subjects from one school to another.

Table III

Order of Presentation of Discrimination and Synthesis Test Numbers by Examiners

Order of Presentation	Examiner I		Examiner II		Examiner III	
	Disc.	Synthesis	Disc.	Synthesis	Disc.	Synthesis
1	5	7	1	1	9	13
2	6	8	2	2	10	14
3	7	9	3	3	11	15
4	8	10	4	4	12	11
5	9	6	5	5	1	12
6	10	13	6	7	2	1
7	11	14	7	8	3	2
8	12	15	8	9	4	3
9	1	11	9	10	5	4
10	2	12	10	6	6	5
11	3	1	11	13	7	7
12	4	2	12	14	8	8

CHAPTER III

RESULTS AND DISCUSSION

A. Test Scoring

The articulation tests were scored to provide measures of (1) the total number of errors, (2) the type of articulatory error, i.e., substitution, distortion, omission or addition and (3) the phoneme in error. Templin assigned one error point to inaccurate production of blends and individual phonemes alike. This procedure was continued in the present study to obtain the total number of errors. Type of error was judged and recorded at the time of testing. Similarly, the phoneme or phonemes in error were also recorded as the child reproduced the test words. Appendix A contains the scoring sheets for the articulation analyses with the stimulus words used in testing.

The test of phonetic discrimination was scored to provide (1) a total error score and (2) the phonemes accurately and inaccurately discriminated. Responses to the test item-pairs consisted of "same" or "different"; consequently, the total number of errors consisted of a count of the number of items inaccurately judged. Counts of the phonemes involved in both accurate and inaccurate discriminations were made directly from the sheets upon which responses were recorded. Appendix B contains the discrimination test recording blanks and the item-pairs for each test number.

The synthesis test was scored by assigning one error point

to each word which could not be recognized or which was incorrectly recognized. Spontaneous responses to the synthesis items, particularly during the first few months of testing, frequently consisted of pointing to the appropriate picture with which the synthesized word could be associated. The primary purpose of the pictures however, was to facilitate phoneme-word associations. Pointing responses were not used in scoring since it would be possible to respond accurately on the basis of chance or on the basis of an inappropriate association of sound and picture. In all cases subjects were required to speak the word which they had synthesized.

The discrimination and synthesis testing was done over a period of fifteen months which necessitated the use of different test forms for each administration. It will be remembered from the discussion of procedures that the examiners rotated in the administration of the several tests so that subjects did not all receive the same test form in the same month. Since equivalence of test difficulty could not be assumed, the obtained raw scores were transformed into standard scores. These were derived for the two subject groups separately by utilizing all raw scores for an individual test form regardless of the month of administration. For example, standard scores were derived from the distribution of all scores on discrimination test number one although the test was administered to sub-groups early, late and about midway in the monthly testing sequence. The obtained standard scores were multiplied by ten and fifty was added to each to obtain Z scores. This

procedure yielded a distribution of scores with a mean of fifty and a standard deviation of ten. These Z scores had the effect of equating test form difficulty. In order to evaluate performance on a monthly basis it was necessary to arrange these Z scores for individual subjects according to the month of administration. Table IV contains the mean error Z scores and standard deviations for discrimination and synthesis test scores and the raw score means and standard deviations for articulation errors by subject group and month of testing.

B. Equating Tests

In addition to the test administrations shown in Table III it was decided to administer additional identical tests to all subjects during the same months. Two such administrations of phonetic discrimination and synthesis abilities were added. The first was administered a few days prior to the regular September, 1958 testing period and the second was completed immediately after the final regularly scheduled testing period in November, 1958. It was anticipated that this procedure would provide a better indication of the absolute performance level and a measure of improvement between the ninth and twelfth months.

Discrimination test nine and synthesis test nine were selected for use as the equating tests. Test nine of the discrimination series was one of those which had been administered to all subjects prior to its use as an equating measure. None of the synthesis tests had been administered to all subjects prior to September, 1958, but test nine had been administered to the majority. Its use as

TABLE IV

Mean Error Scores and Standard Deviations
for Normal and Mentally Retarded Subject Groups

	Month of Test Administration											
	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Sept.	Oct.	Nov.
ARTICULATION												
Normal M	12.48	12.42	11.19	10.53	8.69	8.35	9.00	7.91	7.58	5.45	5.69	5.06
σ	9.27	10.00	9.97	9.87	9.31	9.42	10.26	9.91	9.13	6.32	6.10	6.81
Retarded M	17.75	16.28	17.45	17.89	17.40	16.98	15.83	17.17	16.60	15.55	15.14	13.85
σ	12.43	11.48	12.86	13.18	14.01	13.44	12.90	13.95	13.90	13.31	13.12	12.24
SYNTHESIS												
Normal M	60.64	58.68	53.34	52.80	53.18	45.43	47.10	48.25	47.52	47.48	43.50	45.60
σ	7.64	11.68	10.47	10.60	11.44	6.53	7.81	9.72	8.84	8.55	6.10	6.73
Retarded M	59.50	55.95	53.75	52.95	50.24	45.71	49.27	46.85	46.25	48.59	43.70	44.95
σ	7.39	10.80	9.82	10.05	11.24	8.24	9.32	9.56	9.25	10.46	6.44	8.61
DISCRIMINATION												
Normal M	55.35		51.07		49.70		51.10		44.69		48.71	
σ	10.97		12.47		9.07		9.80		7.93		7.64	
Retarded M	51.26		50.50		50.10		50.41		48.68		49.15	
σ	13.03		9.93		9.46		9.85		10.58		10.29	

Note: Means and standard deviations for articulation computed on raw scores.
Means and standard deviations for synthesis and discrimination computed on Z scores.

an equating measure was judged to be satisfactory, particularly since highly similar tests had been administered for nine previous testing periods.

The results of these equating tests administrations indicated that both normal and retarded groups achieved very high scores on the second administration. Several of the subjects, particularly in the normal group, achieved perfect scores. Consequently, only the results of the first equating discrimination and synthesis tests were considered to be adequate for statistical use.

C. Test Reliabilities

Coefficients of reliability were determined for each of the test types utilized in the study. Test-retest procedure was used in determination of reliability for the articulation test. The articulation test results for two adjacent months were selected at random from the 11 possible month-pairs; April and May 1957 test scores were used. The reliability coefficient computed for normal subjects was .97 while that for the retarded group was .98. Other indirect evidence of the reliability of articulatory judgements is shown by the high agreement among examiners in Table II of Chapter II.

Reliability of the discrimination tests was approximated from the coefficient computed for one randomization of the discrimination items. The split-half method was used for the scores obtained on the October-November 1957 test. Co-efficients of .85 and .86 were obtained for the normal and retarded groups respectively after application of the Spearman-Brown Prophecy Formula.

Synthesis test reliability was also computed using the split-half technique and correcting by the Spearman-Brown Prophecy Formula. Synthesis test number seven was used since it was one of those administered to all subjects. The obtained reliability coefficients were .90 and .97 for normal and retarded groups respectively.

D. Comparisons of Scores for Rome State School and Syracuse Public School Retarded Subjects

Several sub-group comparisons were made as an aid in determining the advisability of treating scores for the institutionalized and public school retarded populations as a single group. These comparisons are also of interest in view of the frequent questions which have been posed in reference to achievement levels of institutionalized and non-institutionalized retarded children. Table V contains mean scores for the two groups. The articulation, synthesis and discrimination mean scores are not significantly different for the two groups. The greatest numerical difference between groups

TABLE V

Mean Scores for Rome State School and Syracuse Public School Retarded Subjects on Mental Age, Intelligence, Articulation, Synthesis and Discrimination

Subjects	M.A.	I.Q.	Articulation	Synthesis	Discrimination
Rome	5.70	59.39	17.67	7.06	15.18
Syracuse	5.77	65.04	17.81	7.08	12.55

Note: Scores for M.A. and I.Q. are as of September, 1957. October, 1957 scores were used for comparisons of articulation, synthesis and discrimination.

occurred for discrimination, but a t of .257 showed this difference to be non-significant (sigmas equalled 7.29 and 7.18 for the Rome and Syracuse groups respectively).

E. Improvement of Phonetic Discrimination, Word Synthesis and Articulation Ability

The raw scores for synthesis and discrimination ability were not directly comparable for all subjects since they were obtained from several different test forms each month. Consequently, absolute levels of performance on these abilities as tested could not be assessed for individuals or subject groups. The mean standard scores as shown in Table IV show a decrease in error scores for both subject groups on discrimination and synthesis tests from first to last test administrations. Figures I and II are plots of these means by month and subject group.

The significance of the mean differences between the first and last auditory and articulation test administrations were computed using the t test for correlated samples. The obtained t values are shown in Table VI. It is apparent that both normal and retarded groups improved in discrimination and synthesis skills during the period covered in this investigation. The improvement in mean scores shown in Table IV which generally occurred from month to month is another indication of the significant improvement found when comparing initial and final mean scores.

Significant improvement in articulation skills for both groups is also apparent from Table VI. Visual representation of this improvement is afforded by Figure 3 which shows the mean level of

FIGURE 1

Curves of Mean Z Scores
for Phonetic Discrimination by Months and Subject Group

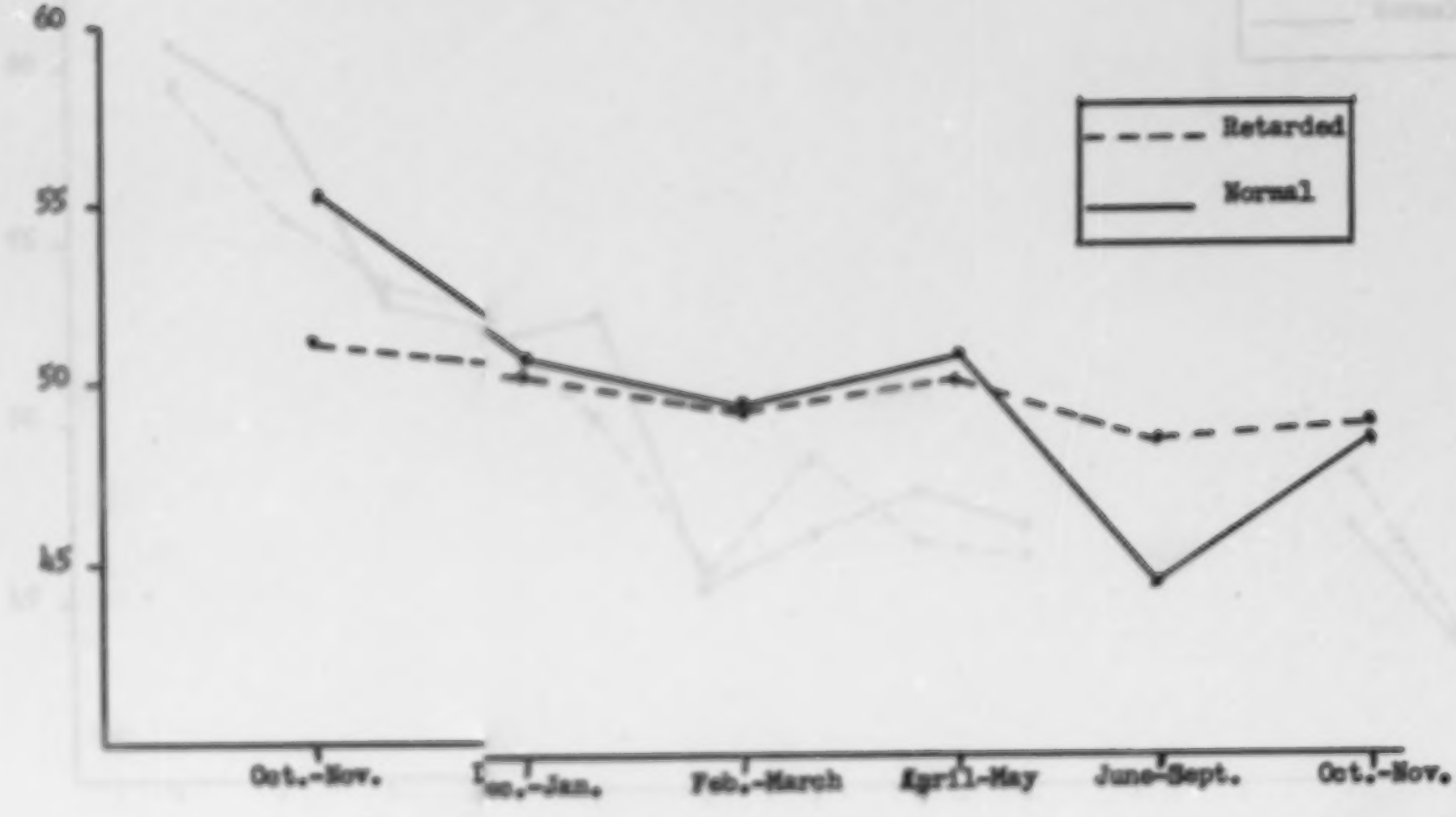

FIGURE 2

Curves Showing Mean Z Scores for Word Synthesis by Month and Subject Group

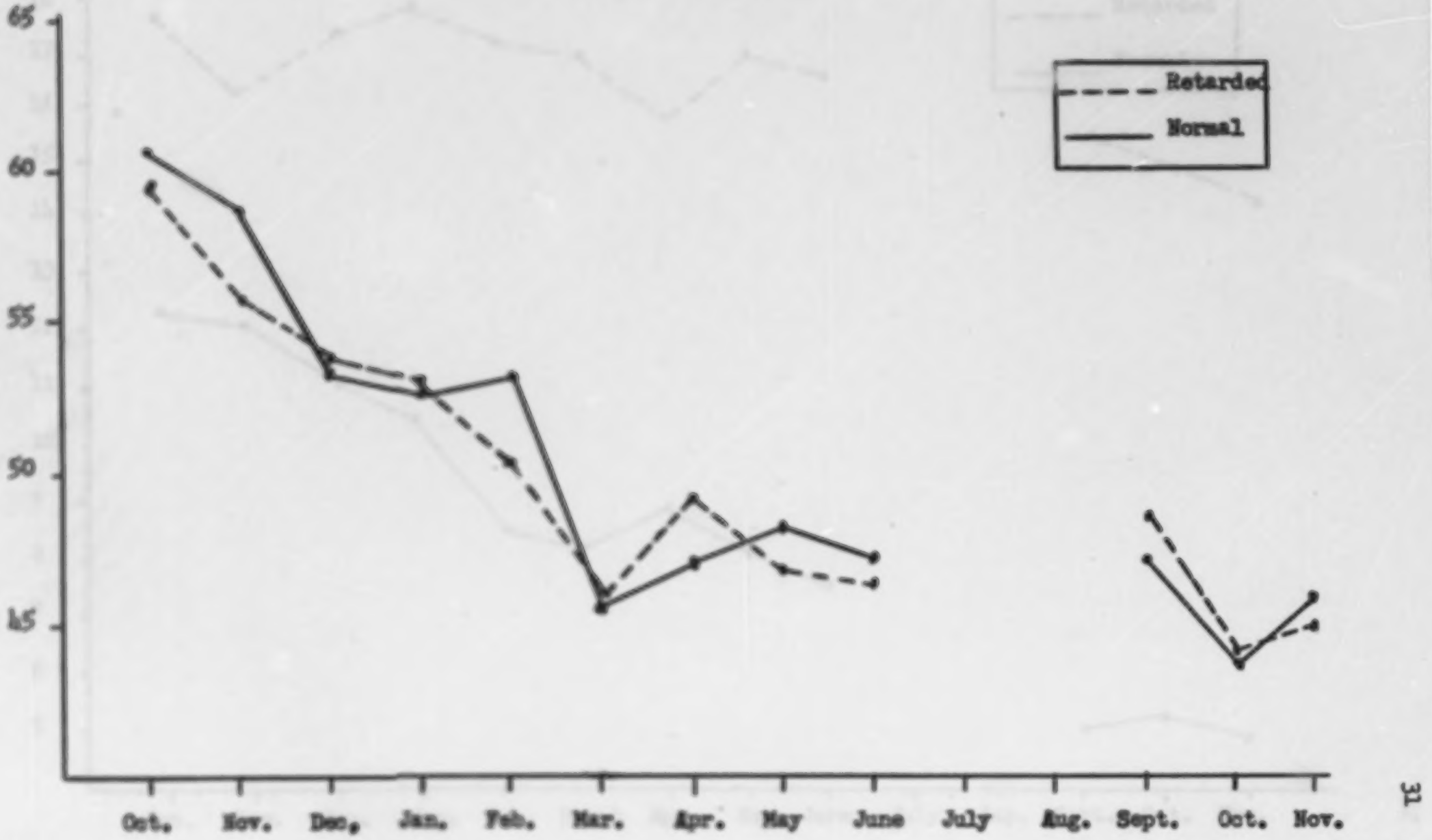

FIGURE 3

Curves Showing Mean Articulation Errors
by Month and Subject Group

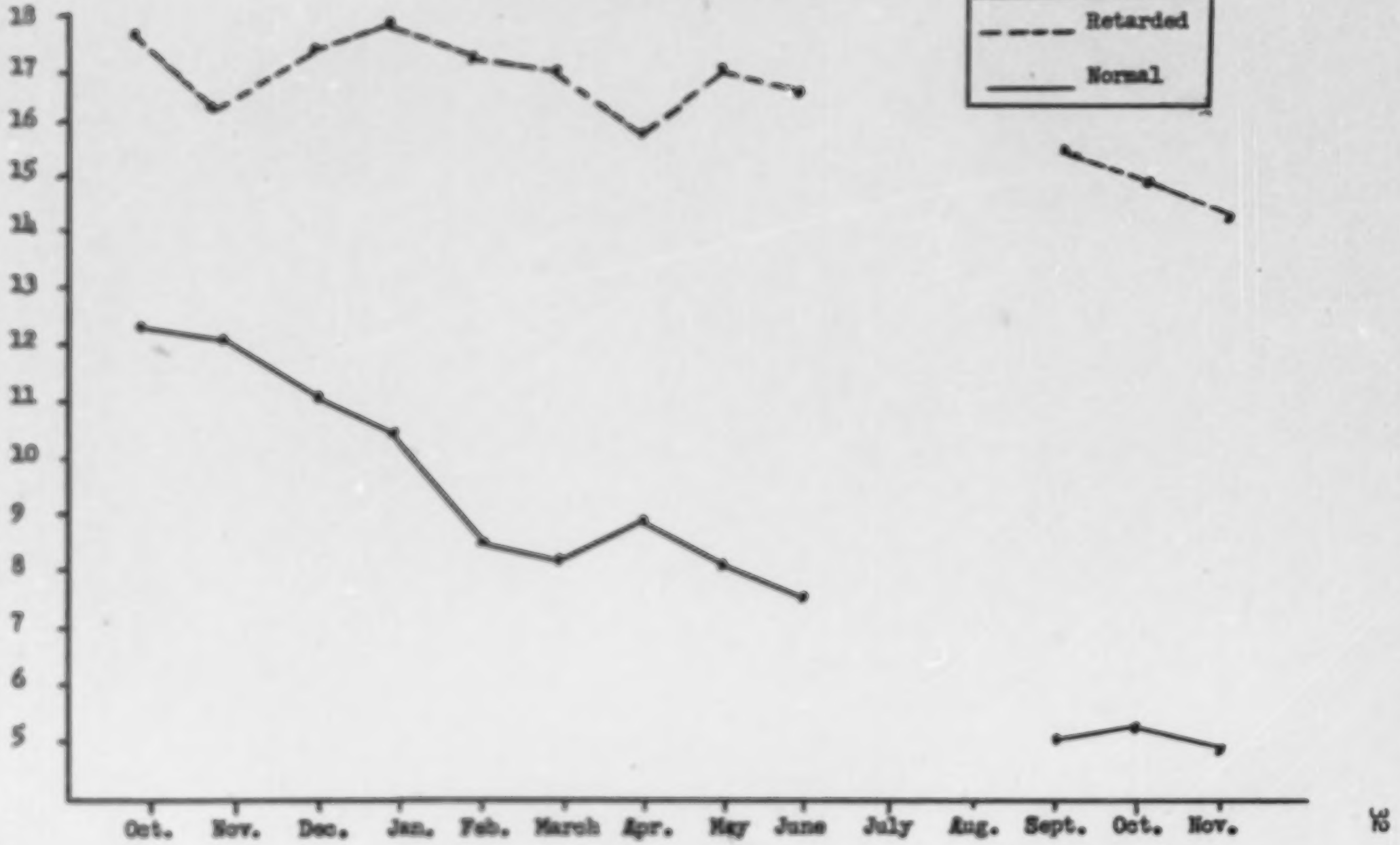

TABLE VI

Mean Difference t-Test Ratios Between
First and Last Auditory and Articulation Test Administrations

Test and Subject Group	t	r	P
Discrimination			
Normal	9.71	.76	.001
Retarded	2.12	.85	.05
Synthesis			
Normal	9.87	.44	.001
Retarded	11.89	.50	.001
Articulation			
Normal	7.71	.78	.001
Retarded	6.00	.94	.001

articulation errors and the decrease in error scores with successive months of development.

The normal intelligence group reduced the mean number of articulation errors by 60% while the mean score for the retarded was reduced 22% from first to last testing. It should not be inferred however, that the rate of articulatory improvement of the normals was three times that for the retarded since Templin's test is heavily loaded with words requiring very advanced articulatory movements as well as those which are more easily produced. Consequently, there is marked intra-test item variability in level of difficulty.

Both subject groups improved rather consistently from month to month although the retarded group was somewhat less consistent. The curve for the normal subjects is somewhat asymptotic since articulation ability is not scaled beyond the point of "normalcy"

by this test. Most non- retarded children approached articulation normalcy by the final testing period.

F. Relationships between Phonetic Discrimination and Articulation Ability.

Since it has been shown that significant improvement occurred in phonetic discrimination, word synthesis and articulation ability for both subject groups, we may profitably examine the inter-relationships between these measures and the improvement which took place. Product-moment correlations were computed between each discrimination test score and the articulation test score corresponding to the month in which the tests were administered. An entire discrimination test score consisted of the sum of scores for the two portions of the test which were administered on successive months. These summed scores were correlated with the articulation test scores obtained at the same testing as the second half of the discrimination tests. In view of the very high reliability of the articulation tests (.97 and .98 for the normal and retarded groups respectively) it was felt that no additional information would be obtained by summing scores for the two articulation tests administered concurrently with the discrimination test.

Table VII contains the correlation coefficients between phonetic discrimination and articulation ability for the two subject groups. Significance levels were computed here and for all correlation coefficients to be reported according to the method described by McNemar (36 , page 147). Similarly, the possibility of curvilinearity was examined for each correlation reported through visual inspection

TABLE VII

Correlation Coefficients between Phonetic Discrimination and Articulation Scores by Month and Subject Group

Subject Group	Months						Equating
	Oct.-Nov.	Dec.-Jan.	Feb.-March	April-May	June-Sept.	Oct.-Nov.	
Normal (N-36)	-.13	.19	.23	.14	.42*	.15	.18
Retarded (N-45)	.33*	.38**	.28*	.32*	.08	.23	.18

* Significantly different from zero at the five percent level of confidence.
** Significantly different from zero at the one percent level of confidence.

of plots.

Pearson r's were also computed using the scores obtained on the discrimination equating test and those of the articulation test administered concurrently. A coefficient of .18 (not significantly different from zero at the five percent level of confidence) was obtained for both normal and retarded groups.

Another measure of the possible relationships between phonetic discrimination and articulation ability was afforded by correlation of the improvement in discrimination with the improvement in articulation which occurred from first to last administrations of the tests. Measures of improvement were taken as the numerical difference between Z scores for individual subjects from first to last testing. The coefficient obtained between improvement in phonetic discrimination and improvement in articulation was .26 for normal subjects and .01 for retarded children; neither was significantly different from zero at the five percent level of confidence.

The results of these several methods of assessing relationships between phonetic discrimination and articulation ability suggest that there is such a relationship, but it is of a relatively low order. Fifteen of the sixteen coefficients were of positive sign; five of these were significantly different from zero at the five percent level of confidence or beyond. Four of the seven coefficients obtained for the retarded group reached significant levels. Consequently, it is probable that the relationship between phonetic discrimination and articulatory ability is greater for the retarded group than for the normal group at these levels of auditory and articulatory development.

G. Phonetic Discrimination Type Judgements

An analysis of the combinations of phonemes and errors accurately judged in the phonetic discrimination task was made for both normal and retarded groups. The discrimination test pairs included combinations in which the sound to be discriminated was sometimes produced normally, sometimes substituted for, sometimes omitted and sometimes distorted. The combinations utilized within item-pairs included normal with normal, normal with substitution, normal with omission, normal with distortion, distortion with distortion and substitution with substitution. The percentage of accurate discriminations of each of these combinations for the October-November, 1957 test, is shown in Table VIII.

TABLE VIII

Percentages of Discrimination Errors
by Item-Pair Combinations for Normal and Retarded Subjects

Subjects	Normal with Distortion	Normal with Subetitution	Normal with Omission	Normal with Normal	Substitution with Substitution	Distortion with Distortion
Normal	43%	21%	8%	3%	4%	1%
Retarded	49%	47%	28%	12%	12%	13%

Note: Total possible errors equal 484 for all combinations except those involving distortions. Total possible errors for combinations involving distortions equal 88.

It is apparent that discriminations between dissimilar pairs yielded the greatest percentages of error for both subject groups. When both stimuli within a pair were identical, relatively little difficulty was encountered in making accurate discriminations. This data suggests that judgements were biased toward a "same" response as shown by the

very high accuracy of judgements when pairs were identical and the relative lack of accuracy when pairs were dissimilar. If such a bias is operating, it is very likely that those discriminations between dissimilar pairs which reached an error level of 40% or more were not mere reflections of a chance factor. When discriminating dissimilar pairs under a bias toward a "same" response the tendency would be in the direction of 100% inaccurate responses. Therefore, the discriminations obtained on these pairs on the present experiment probably afford a reasonably accurate reflection of phonetic discrimination ability. The discriminations between similar pairs probably added little information regarding phonetic discrimination ability, at least for the normal subjects.

Attempts were made to relate discrimination type judgements as shown in Table VIII to the articulation patterns displayed by individual children. This was done by analyzing articulation profiles according to the percentage of each error type present in speech, i.e., distortion, substitution and omission. Similarly, percentages of errors in discriminations involving distortions, substitutions and omissions were also computed for individual subjects. This procedure was followed for both retarded and normal subjects using data from the initial articulation and discrimination tests. When these percentages were plotted and analyzed by visual inspection, no evidence of a significant relationship was found.

H. Relationships between Word Synthesis and Articulation Ability

Pearson r's were computed between the monthly Z scores for synthesis ability and the corresponding articulation test scores for both subject groups. These coefficients are shown in Table IX; none are

TABLE IX

Correlation Coefficients between Word Synthesis and Articulation Scores by Month and Subject Group

Subject Group	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Sept.	Oct.	Nov.
					Months							
Normals	.17	.08	.32	.31	.20	.11	.03	-.05	.24	.24	-.04	.20
Retarded	.13	.25	.02	.13	.21	.06	.11	.17	-.03	.14	-.02	.11

Note: No coefficient reached the five percent level of confidence.

significantly different from zero at the five percent level of confidence.

Relationships between equating synthesis test scores and corresponding articulation test scores were also computed using product-moment correlation. Coefficients obtained between these measures were .31 for normal subjects and -.12 for retarded children. Neither of these values was significantly different from zero at the five percent level of confidence.

Relationships between improvement in synthesis and articulation ability were assessed using improvement scores derived in the same manner as discussed for discrimination scores. The values obtained for these coefficients were -.18 and -.06 for normal and retarded groups respectively; neither was significantly different from zero at the five percent level of confidence.

These measures showed no evidence of a relationship between word synthesis and articulation ability. Although 21 of the 28 coefficients were of positive sign, the very small magnitude of the coefficients makes any possible trend toward a relationship of little importance.

I. Relationships between Phonetic Discrimination and Word Synthesis Ability.

The relationships between phonetic discrimination and word synthesis abilities were also of interest in this investigation since these relationships have not been assessed previously. It was assumed however, that the relationships would be of a low order as suggested by the results of the factor analysis studies discussed previously. Pearson r's were computed between phonetic discrimination (summed

two month scores) and synthesis test scores. These are shown in Table X. Six of the seven coefficients for the retarded were of positive sign and reached significance at the five percent level of confidence or better. The only coefficient reaching significance for the normal group was that for the equating tests. All other coefficients for the normal group were of positive sign however.

Correlation coefficients between discrimination and synthesis improvement scores were also computed. A coefficient of .06 (not significantly different from zero at the five percent level of confidence) was obtained for normal subjects, while .30 (significantly different from zero at the five percent level) was obtained for the retarded group.

The above correlation coefficients were computed on the scores for two tests which were designed to sample abilities of an auditory perceptive nature. The results suggest a relationship between the abilities, but it is probably of low order as shown by the magnitude of the obtained values. These results tend to support the assumption that the discrimination and synthesis tests sampled relatively independent auditory perceptual abilities.

J. Inter-Group Comparisons of Articulation

Comparisons of the differences between mean articulation error scores for the two groups were made through the use of t-tests with the Cochran - Cox adjustment. These ratios are shown in Table XI together with the F ratios used for comparing the significance of the differences in standard deviations for the two groups. Differences

TABLE X

Correlation Coefficients between Phonetic
Discrimination and Word Synthesis Scores for Normal and Retarded Subjects

Subject Group	Month						Equating Test
	Oct.-Nov.	Dec.-Jan.	Feb.-March	April-May	June-Sept.	Oct.-Nov.	
Normals	.26	.02	.26	.24	.22	.00	.61**
Retarded	-.07	.41**	.29*	.34*	.48**	.34*	.31*

** significantly different from zero at the one percent level of confidence.
* Significantly different from zero at the five percent level of confidence.

TABLE XI

Comparisons of Mean Articulation Error
Scores and Standard Deviations between Normal and Retarded Subjects

	Month of Administration											
	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Sept.	Oct.	Nov.
Means Diff. t	2.17*	1.63	2.50*	2.86**	3.27**	3.26**	2.61*	3.46**	3.46**	4.58**	4.30**	4.06**
Sigmas Diff. F	1.80*	1.25	1.66	1.78*	2.33**	2.04*	1.58	1.98*	2.32**	4.44**	4.63**	3.23**

* significant at the five percent level of confidence.
**significant at the one percent level of confidence.
Note: significance levels to be doubled for F values.

between mean error scores reached the five percent level of significance or better for all t's except for the month of November 1957. It is interesting to note that inter-group differences in mean number of articulation errors exist in the early months of testing when the mental age levels of the two groups were more nearly equal. This may be partially explained by the four month mean mental age differential in favor of the normal subjects as shown in Table I. It is likely that if the curve of Figure 3 were extrapolated backward in time to a point of equivalent inter-group mental age, there would be no difference between the retarded and normal subjects in number of articulation errors.

The highly significant differences in the variances of the two groups on articulation scores are also of interest. For the normal group the standard deviations remain very close to 10.0 errors during the first nine months of testing after which there is a sharp decrease. This decrease is undoubtedly due to the attenuation of scores resulting from the near normal articulatory patterns present during the final three test administrations. A sigma of approximately 10.0 points appears to be a good reflection of the true sigma for the normal group under these test conditions. The standard deviations for the retarded group appear to center around 13.0 points and are relatively constant throughout the entire testing period.

K. Summary of Results

1. No significant differences were found between mean scores obtained by institutionalized and public school retarded children in articulation, phonetic discrimination or word synthesis tasks for

the October, 1957 test administration.

2. Significant improvement occurred for both normal and retarded subjects in articulation, phonetic discrimination and word synthesis ability during the fifteen month period covered by this investigation. Levels of significance reached .001 for all comparisons between first and last test administrations for both groups with the exception of that for discrimination in the retarded group which reached the .05 level.

3. Correlation coefficients between phonetic discrimination and articulation scores reached significance (five percent level of confidence or better) in four of seven computations for the retarded group and in one of seven computations for the normal group.

4.Correlation coefficients between word synthesis scores and articulation scores failed to reach the five percent level of confidence for either subject group on any of the monthly test scores.

5.Improvement scores for phonetic discrimination or word synthesis ability did not correlate significantly with improvement in articulatory skill for either normal or mentally retarded subjects.

6. Analyses of articulatory error type revealed no evidence of any relationship to discrimination error type as judged from visual inspection of the plots for distortion, substitution and omission errors.

7. A low but significant correlation was found between phonetic discrimination and word synthesis scores for both normal and retarded subjects.

8. The mean number of articulation errors did not appear to be

significantly different for normal and mentally retarded subjects when adjustments were made for equivalence of mental age.

9. Significant differences in the dispersion of articulation scores of normal and retarded subjects were found for nine of the twelve tests administered.

Five principal conclusions appear to be justified by the data obtained.

1. There is a low but positive relationship between the ability to make accurate phonetic discriminations during the years of articulation development in childhood.

2. There is no relationship between the ability to articulate accurately and word synthesis ability for non-speech defective children during the years of articulation development in childhood.

3. There is no relationship between articulation error type and phonetic discrimination error type during the years of articulation development in childhood.

4. Phonetic discrimination and word synthesis abilities are relatively independent measures of auditory perceptual ability.

5. The variability in number of articulation errors is greater for the mentally retarded than for those of normal intellectual ability during the years of articulation development in childhood.

The data are also suggestive of two other tentative conclusions.

1. There are no differences between an institutionalized and a public school population of mentally retarded children in articulation, phonetic discrimination and word synthesis abilities.

2. Articulatory ability of the mentally retarded does not differ

from that of a normal population of equivalent mental age with respect to number of articulation errors present during the articulation development years of childhood.

The presence of relationships between the auditory perceptual abilities of phonetic discrimination and word synthesis among articulation defectives provided a portion of the stimulus for conducting the present study. It was anticipated that these relationships would be even more apparent during the early years of life when the modification and improvement of articulatory skill is an active process. The results of this study did not strongly support this assumption. This finding may be explained in at least two ways. First, we may hypothesize that the auditory perceptual skills measured are of no importance to the development of articulation. This hypothesis however, appears to be untenable in view of the demonstrated importance for certain articulation defective subjects. Consequently, a second hypothesis is required which will explain the existence of relationships in one group but not in the other. The most likely explanation is that these auditory skills are of importance in articulation development, but that the non-speech defective population has greater auditory perceptual ability than is required for normal development of articulation. Consequently, the variability and improvement in auditory skills which were present did not bear a strong relationship to articulation ability.

The low positive relationships found between discrimination and articulation are of about the same order of magnitude as those obtained by Templin (3) when intelligence was partialled out. The fact that

the coefficients tend to become lower (3, page 141) with increasing age lends further support to the second hypothesis suggested above.

From these results, it would appear that use of auditory perceptual activities, such as those used in this study, for improvement of articulatory development among non-speech defective children is of little value. The use of such activities with articulation defective subjects has also yielded equivocal results (). As a result of this and other information it appears that there is much which we do not yet understand concerning the skills required for normal articulation development.

Investigations which have been directed toward definition of the role of single factors or groups of factors in articulation skills have created as many questions as they have attempted to answer. It now seems quite clear that articulation skills, defective or normal, are not dependent upon the intact functioning of single abilities. Rather, it is highly probable that multiple factors are operative. As a result, the studies which measure a multiplicity of such skills are much more likely to be productive of significant findings in the statistical sense and in provision of relevant and practical therapeutic approaches.

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APPENDICES

APPENDIX A

ARTICULATION RECORD

No.___

Name_____Sex____Birthdate_____Date_____

Address_____Phone_____C____M____I_____

School_____Teacher_____Examiner_____

I	M	F	Word	✓	Dist.	Subst.	OM	Add	Defective Sounds
r	tʃ		reaching						
sk			skate						
br	ʒ		brother						
ʃ			shoe						
sp	ʃ		splashing						
sn			snow						
j			yellow						
t	ʃ		cherry						
sl			sled						
	ð		anything						
gr			grass						
kl		θ	cloth						
ʒ			there						
fl			flower						
spr			spring						
θ			thumb						
tr			truck						
v			valentine						
sp			spoon						
dʒ			jump						
θr			throw						
pr			present						
ʃr			shrink						

APPENDIX A

ARTICULATION RECORD

No.___

Name_____Sex____Birthdate_____Date_____

Address_____Phone_____C_____M_____I_____

School_____Teacher_____Examiner_____

I	M	F	Word	✓	Dist.	Subst.	OM	Add	Defective Sounds	
sw			swing							
dr			drum							
st			stove							
gl		s	glass							
skr		tʃ	scratch							
fr		ʃ	fresh							
sm		ʃ	smooth							
kr			cracker							
z			zipper							
p	ʒ		pleasure							
l	dʒ		larger							
	nj		onion							
	ʃ		bird							
	tr		straw							
	juz		music							
tw			twins							
kw			queen							

APPENDIX B

DISCRIMINATION TEST

Name_____ School_____

Grade_____ Date_____

Test 1				Test 2			
	like	ike	____		like	wike	____
	jump	ump	____		jump	zump	____
	wike	wike	____		like	like	____
	su	su	____		shoe	shoe	____
	shoe	oo	____		shoe	su	____
	thumb	umb	____		thumb	fum	____
	fun	un	____		fun	thun	____
	won	won	____		run	run	____
	this	iss	____		this	dis	____
	vine	ine	____		vine	bine	____
	dis	dis	____		this	this	____
	run	run	(d)____		run	run	(d)____
	fum	fum	____		thumb	thumb	____
	ton	ton	____		sun	sun	____
	sipper	sipper	____		zipper	zipper	____
	bine	bine	____		vine	vine	____
	shun	shun	(d)____		sun	sun	(d)____
	run	un	____		run	won	____
	sun	un	____		sun	ton	____
	tear	tear	____		chair	chair	____
	zump	zump	____		jump	jump	____
	chair	air	____		chair	tear	____
	zipper	ipper	____		zipper	sipper	____
	thun	thun	____		fun	fun	____

APPENDIX B

DISCRIMINATION TEST

Name_____ School_____

Grade_____ Date_____

Test 3				Test 4			
	shun	shun	(d)____		shun	sun	(d)____
	sipper	sipper	____		zipper	zipper	____
	ike	like	____		wike	like	____
	un	sun	____		tun	sun	____
	bine	bine	____		vine	vine	____
	tun	tun	____		sun	sun	____
	air	chair	____		tear	chair	____
	fum	fum	____		thumb	thumb	____
	ine	vine	____		bine	vine	____
	tear	tear	____		chair	chair	____
	um	thumb	____		fum	thumb	____
	thun	thun	____		fun	fun	____
	dis	dis	____		this	this	____
	ump	jump	____		zump	jump	____
	zump	zump	____		jump	jump	____
	ipper	zipper	____		like	like	____
	su	su	____		wun	run	____
	iss	this	____		run	run	____
	wike	wike	____		su	shoe	____
	un	run	____		run	run	____
	won	won	____		thun	fun	____
	$\overline{oo}$	shoe	____		sipper	zipper	____
	run	run	____		shoe	shoe	____
	un	fun	____		dis	this	____

APPENDIX B

DISCRIMINATION TEST

Name_____ School_____

Grade_____ Date_____

Test 5				Test 6			
	shun	shun	(d)____		sun	shun	(d)____
	chair	air	____		chair	tear	____
	dis	dis	____		this	this	____
	wike	wike	____		like	like	____
	sipper	sipper	____		zipper	zipper	____
	this	isc	____		this	dis	____
	sun	un	____		sun	tun	____
	run	run	(d)____		run	run	(d)____
	tear	tear	____		chair	chair	____
	zump	zump	____		jump	jump	____
	like	ike	____		like	wike	____
	thumb	um	____		thum	fum	____
	fun	un	____		fun	thun	____
	su	su	____		shoe	shoe	____
	shoe	$\overline{oo}$	____		shoe	soo	____
	fum	fum	____		thumb	thumb	____
	bine	bine	____		vine	vine	____
	wun	wun	____		run	run	____
	jump	ump	____		jump	zump	____
	vine	ine	____		vine	bine	____
	thun	thun	____		fun	fun	____
	tun	tun	____		sun	sun	____
	run	un	____		run	wun	____
	zipper	ipper	____		zipper	sipper	____

APPENDIX B

DISCRIMINATION TEST

Name_____ School_____

Grade_____ Date_____

Test 7				Test 8			
	dis	dis	____		this	this	____
	un	run	____		wun	run	____
	fum	fum	____		bine	vine	____
	un	sun	____		tun	sun	____
	tear	tear	____		chair	chair	____
	zump	zump	____		jump	jump	____
	shun	shun	(d)____		shun	sun	(d)____
	thun	thun	____		fun	fun	____
	air	chair	____		tair	chair	____
	ike	like	____		wike	like	____
	um	thum	____		fum	fum	____
	o͞o	shoe	____		shoe	su	____
	bine	bine	____		vine	vine	____
	iss	this	____		dis	this	____
	run	run	(d)____		run	run	(d)____
	un	fun	____		thun	fun	____
	wike	wike	____		like	like	____
	sipper	sipper	____		zipper	zipper	____
	tun	tun	____		sun	sun	____
	ipper	zipper	____		sipper	zipper	____
	ine	vine	____		bine	vine	____
	wun	wun	____		run	run	____
	ump	jump	____		zump	jump	____
	su	su	____		shoe	shoe	____

APPENDIX B

DISCRIMINATION TEST

Name_____ School_____

Grade_____ Date_____

Test 9				Test 10			
	shoe	oo	____		shoe	soo	____
	fun	un	____		fun	thun	____
	vine	ine	____		vine	bine	____
	tear	tear	____		chair	chair	____
	wike	wike	____		like	like	____
	zump	zump	____		jump	jump	____
	fum	fum	____		this	dis	____
	chair	air	____		chair	tear	____
	dis	dis	____		this	this	____
	thum	um	____		thum	fum	____
	thun	thun	____		fun	fun	____
	sun	un	____		sun	tun	____
	bine	bine	____		vine	vine	____
	like	ike	____		like	wike	____
	run	run	(d)____		run	run	(d)____
	zipper	ipper	____		zipper	sipper	____
	run	un	____		run	wun	____
	this	iss	____		this	dis	____
	shun	shun	(d)____		sun	shun	(d)____
	wun	wun	____		run	run	____
	soo	soo	____		shoe	shoe	____
	sipper	sipper	____		zipper	zipper	____
	tun	tun	____		sun	sun	____
	jump	ump	____		jump	zump	____

APPENDIX B

DISCRIMINATION TEST

Name_____ School_____

Grade_____ Date_____

Test 11	wike	wike		Test 12	like	like		
	su	su			shoe	shoe		
	wun	wun			run	run		
	shun	shun	(d)		shun	sun	(d)	
	tun	tun			fum	thumb		
	ump	jump			zump	jum		
	sipper	sipper			zipper	zipper		
	run	run	(d)		run	run	(d)	
	ine	vine			bine	vine		
	fum	fum			thumb	thumb		
	ike	like			wike	like		
	iss	this			dis	this		
	bine	bine			vine	vine		
	zump	zump			jump	jump		
	um	thumb			fum	thumb		
	thun	thun			fun	fun		
	un	run			wun	run		
	ipper	zipper			sipper	zipper		
	dis	dis			this	this		
	un	sun			tun	sun		
	oo	shoe			su	shoe		
	un	fun			thun	fun		
	tear	tear			chair	chair		
	air	chair			tear	chair		

APPENDIX C

Name_____ School_____

Grade_____ Date_____

SET 1

WORD	RESPONSE	WORD	RESPONSE	WORD	RESPONSE
SHINE		REACH		TWO	
EAT		RACE		SOAP	
COOK		PAN		TIE	
CHURCH		TIRE		SEE	
ROLL		PIN		NAIL	
TOTAL		TOTAL		TOTAL	

SET 2

WORD	RESPONSE	WORD	RESPONSE	WORD	RESPONSE
PASS		FIRE		PUSH	
PIES		SIT		ICE	
SNOW		SAW		RUN	
LAUGH		TEACH		MEN	
MAN		TOYS		FISH	
TOTAL		TOTAL		TOTAL	

SET 3

WORD	RESPONSE	WORD	RESPONSE	WORD	RESPONSE
MOUTH		NOSE		CAP	
SHOE		FACE		MOUSE	
PICK		SICK		TIME	
ROPE		SOUP		CHAIR	
LAKE		SHIP		TAKE	
TOTAL		TOTAL		TOTAL	

APPENDIX C

NAME _____ SCHOOL _____

GRADE _____ DATE _____

SET 4

WORD	RESPONSE	WORD	RESPONSE	WORD	RESPONSE
SING		TEETH		CHAIN	
TALK		PIE		SUN	
CAR		CAT		CUT	
PAIL		SHIRT		TALL	
FEET		PAY		PIPE	
TOTAL		TOTAL		TOTAL	

SET 5

WORD	RESPONSE	WORD	RESPONSE	WORD	RESPONSE
CAN		FAT		AIM	
MOON		SKY		NECK	
CATCH		RING		TURN	
SEW		RAIN		CUP	
NIGHT		SIGN		COAT	
TOTAL		TOTAL		TOTAL	

SET 6

WORD	RESPONSE	WORD	RESPONSE	WORD	RESPONSE
RACE		CHURCH		PAN	
EAT		TWO		TIE	
REACH		SHINE		SHE	
TIRE		ROLL		COOK	
SOAP		PIN		NAIL	
TOTAL		TOTAL		TOTAL	

APPENDIX C

NAME_____ SCHOOL_____

GRADE_____ DATE_____

SET 7

WORD	RESPONSE	WORD	RESPONSE	WORD	RESPONSE
LAUGH		SNOW		ICE	
TOYS		PIES		MEN	
TEACH		MAN		SAW	
PUSH		FISH		RUN	
FIRE		PASS		SIT	
TOTAL		TOTAL		TOTAL	

SET 8

WORD	RESPONSE	WORD	RESPONSE	WORD	RESPONSE
TAKE		TIME		FACE	
SHIP		MOUSE		SHOE	
ROPE		NOSE		MOUTH	
CAP		SOUP		LAKE	
SICK		CHAIR		PICK	
TOTAL		TOTAL		TOTAL	

SET 9

WORD	RESPONSE	WORD	RESPONSE	WORD	RESPONSE
CAT		TALL		CAR	
CUT		PIE		TEETH	
SING		CHAIN		SUN	
PAIL		TALK		PAY	
PIPE		SHIRT		FEET	
TOTAL		TOTAL		TOTAL	

APPENDIX C

NAME _____ SCHOOL _____

GRADE _____ DATE _____

SET 10

WORD	RESPONSE	WORD	RESPONSE	WORD	RESPONSE
RING		TURN		MOON	
COAT		NECK		AIM	
RAIN		CATCH		CUP	
FAT		CAN		SIGN	
SEW		NIGHT		SKY	
TOTAL		TOTAL		TOTAL	

SET 11

WORD	RESPONSE	WORD	RESPONSE	WORD	RESPONSE
CHURCH		SHINE		COOK	
TIE		NAIL		TWO	
PAN		ROLL		TIRE	
SHE		EAT		PIN	
SOAP		REACH		RACE	
TOTAL		TOTAL		TOTAL	

SET 12

WORD	RESPONSE	WORD	RESPONSE	WORD	RESPONSE
PIES		ICE		TOYS	
SIT		PASS		FIRE	
LAUGH		RUN		FISH	
SNOW		MEN		SAW	
MAN		TEACH		PUSH	
TOTAL		TOTAL		TOTAL	

APPENDIX C

NAME_____ SCHOOL_____

GRADE_____ DATE_____

SET 13

WORD	RESPONSE	WORD	RESPONSE	WORD	RESPONSE
FACE		TIME		PICK	
CHAIR		TAKE		LAKE	
SOUP		CAP		MOUTH	
NOSE		MOUSE		ROPE	
SICK		SHIP		SHOE	
TOTAL		TOTAL		TOTAL	

SET 14

WORD	RESPONSE	WORD	RESPONSE	WORD	RESPONSE
PIE		FEET		PAIL	
PAY		SING		TEETH	
TALL		CAR		SHIRT	
CHAIN		SUN		PIPE	
TALK		CUT		CAT	
TOTAL		TOTAL		TOTAL	

SET 15

WORD	RESPONSE	WORD	RESPONSE	WORD	RESPONSE
NIGHT		MOON SKY		SKY	
TURN		RAIN		ARM	
CATCH		FAT		SIGN	
CUP		RING		SEE	
CAN		NECK		COAT	
TOTAL		TOTAL		TOTAL	